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A NEW TYPE OF TEMPERATURE GRAPH FOR THE GEOGRAPHER

By GEORGE F. DEASY

[Arlington, Va., December 1940]

Geography has been too long content with inadequate means for representing temperature data. The mean monthly temperature graph alone, in common use today, is poorly suited to the portrayal of many facts of geographic significance. Several additional types of graphs are available,¹ but each has one or more features that have prevented its general adoption by geographers.

It is in an effort to integrate what appears to the author to be the most desirable qualities of previous temperature graphs, as well as to add several additional features, that the type of temperature chart here described is proposed. The purpose of this graph is to show simultaneously the four temperature facts of major geographic significance, namely: (1) Normal annual range, (2) normal diurnal range, (3) the frequency and vigor of daily temperature irregularities, and (4) the normal length of the growing season. At the same time it aims to eliminate the main objectionable features of previous graphs.

In essence this new graph is a simplified form of the diagram used by Kincer,¹ with a more refined and legible system of "key lines,"² as well as an indicator of the average length of the growing season (fig. 1). The four temperature curves show mean monthly maximum, mean monthly minimum, absolute monthly maximum, and absolute monthly minimum temperatures. The extent of annual temperature range is clearly shown by the sweep of all four curves. The space between the mean maximum and mean minimum curves is shaded and represents the expected or normal diurnal temperature range during the various months of the year. Daily temperature irregularities for each month will be found to correspond closely to the relative proximity of the absolute curves to the mean curves.³ The expanded "key line" system of horizontal coordinates separates frigid temperatures (below 0° F.) from cold (0° to 32° F.), from cool (32° to 50° F.), from mild (50° to 68° F.), from warm (68° to 80° F.), from hot temperatures (above 80° F.).⁴ The "key points" (black dots) are significant since

they show at what times of the year the normal and absolute maximum day and minimum night temperatures pass from one temperature phase to another. The average length of the growing season is shown by a bar extending across the appropriate months and placed near the bottom of the graph.

A brief analysis of this type of temperature graph for Cincinnati (fig. 1) will show the wealth of temperature

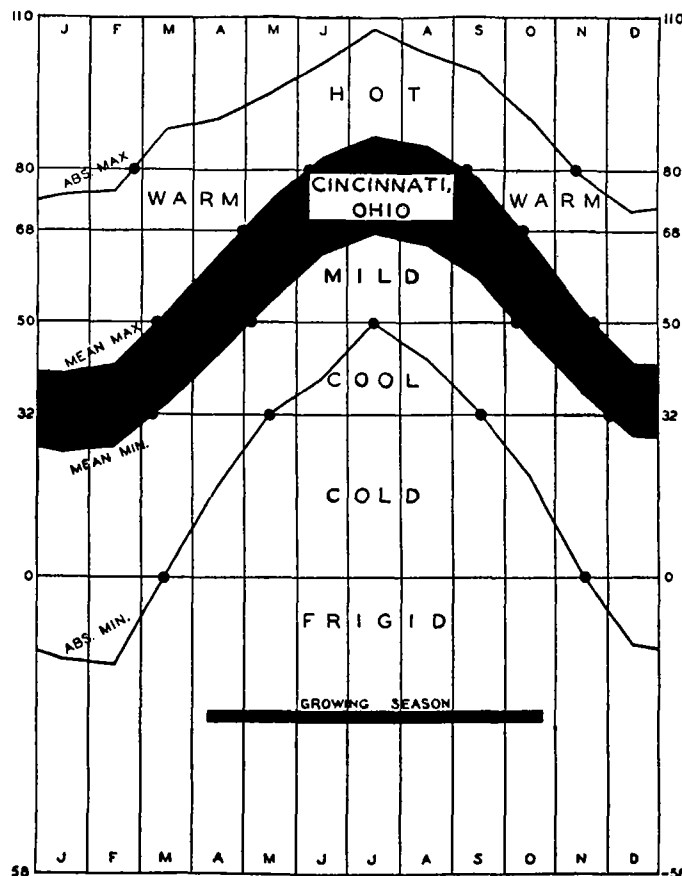


FIGURE 1.—New type temperature graph for Cincinnati, Ohio.

facts of geographic significance that can be derived almost at a glance. The considerable swing of the shaded zone from cold to hot between winter and summer indicates a "continental" temperature regime with a fairly great seasonal range. The moderate width of the shaded area, between the mean maximum and mean minimum lines, signifies that diurnal temperature range is neither excessively large nor small, as would be expected of a humid, middle-latitude station located at a relatively low elevation. The greater width of the shaded area during summer, as compared with winter, means that normal

¹ Jefferson, M., "The Steady Warmth of the Tropics," *Bul. American Geographical Society*, v. 47, 1915, pp. 346-48.

Jefferson, M., "The Real Temperatures Throughout North and South America," *Geographical Review*, v. 6, 1918, pp. 240-67.

Kincer, J. B., "Temperature, Sunshine, and Wind," in *Atlas of American Agriculture*, 1936, pp. 1-30.

² The term "key lines" refers to those critically located boundary lines on a temperature graph that separate temperature zones from one another. Such "key lines" were included by both Jefferson and Kincer in their graphs; but in both cases they were accompanied by and made subordinate to a 10° grid, and no descriptive terms, such as "hot," "warm," "mild," etc., were indicated on the graph within the respective interline ranges. Hence, the value of the "key lines" has been largely negated.

³ In general, the greater the frequency and vigor of temperature irregularities from day to day for a given station (or a given month), the greater will be the distance between the corresponding absolute and mean temperature curves of the graph; the less the daily irregularities in temperature, the smaller will be the distance between the related curves. Kincer failed to note this relation in the text accompanying his graphs in the *Atlas of American Agriculture*.

⁴ It might be argued that descriptive terms such as "hot" or "cool" are only relative, since they depend upon humidity conditions, and that dividing lines between such temperature ranges are arbitrary and do not apply with equal validity to arid, semiarid, and humid regions. Such criticism, however, is no more applicable to the "key lines" of temperature graphs than to the boundary lines employed in the widely-accepted "temperature-region" or "thermal-region" maps of the world.

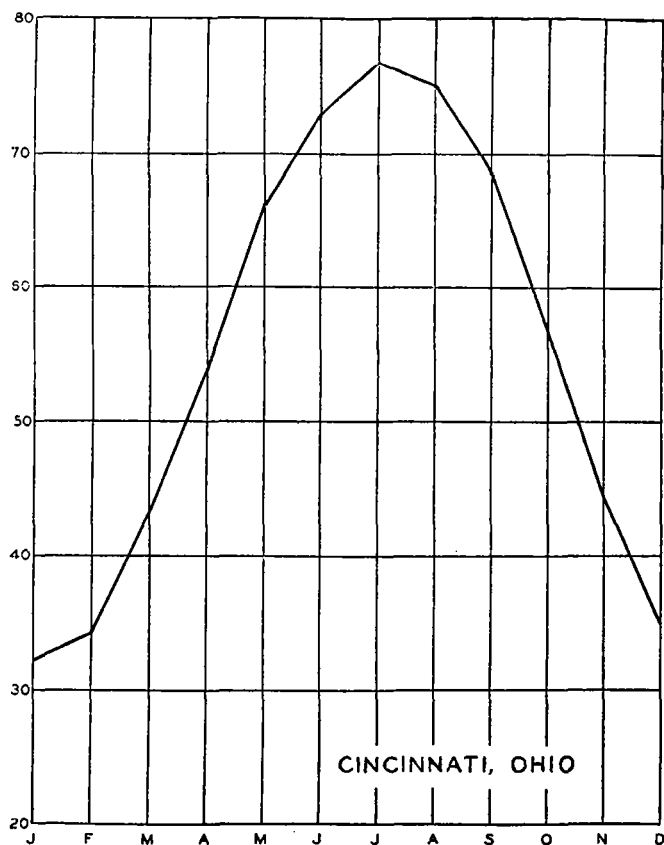
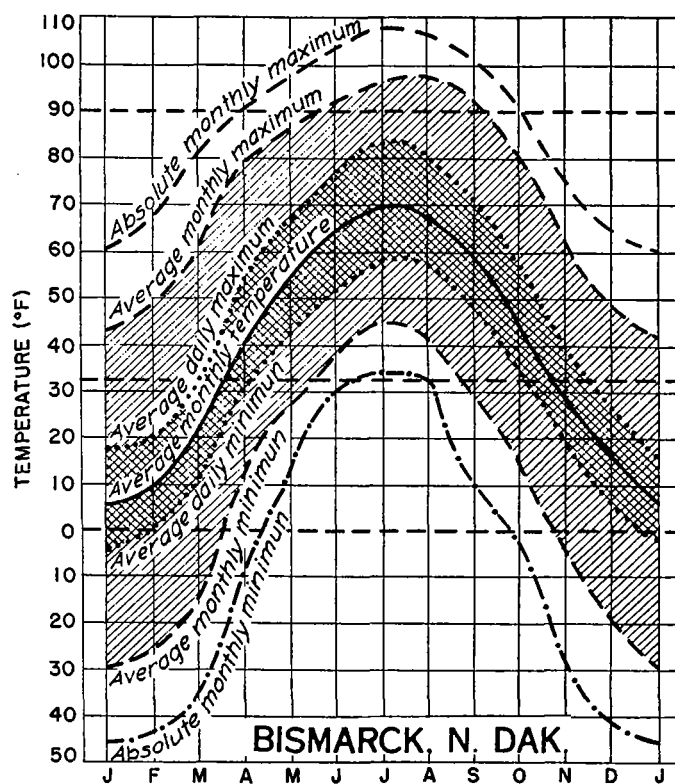


FIGURE 2.—Mean monthly temperature graph for Cincinnati, Ohio.

diurnal range is greater in the former season when sun control is at a maximum; however, the relatively greater divergence of the absolute maximum and minimum lines

FIGURE 4.—Type of temperature graph for Bismarck, N. Dak., used by Kincer. Reproduced from *Atlas of American Agriculture*, Part II, Figure 72, p. 22.

most numerous and well developed. The bar near the base of the graph indicates that the normal period without killing frost is in excess of 6 months.

A comparison of this temperature graph for Cincinnati

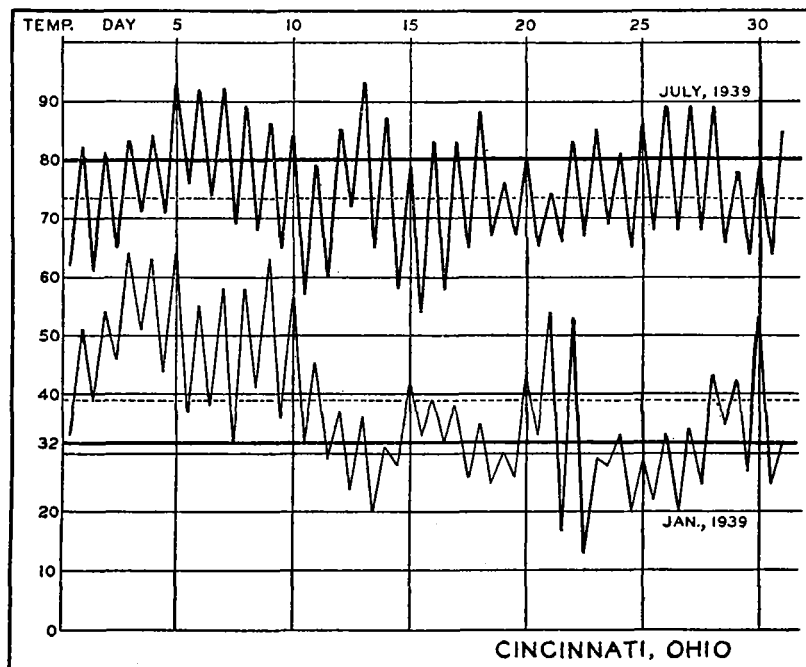


FIGURE 3.—Type of temperature graph for Cincinnati, Ohio, used by Jefferson.

from the shaded zone during winter, as compared with summer, indicates that *extremes* of temperature irregularities are most likely to occur with greater frequency and vigor during the winter months when storms are

with other types of graphs for the same city and for Bismarck, N. Dak., makes an instructive study (figs. 1, 2, 3, and 4). Note the inability of the conventional single-line temperature graph to convey a complete mental

picture of actual temperature conditions. Observe how difficult it is to obtain a general and concrete impression of temperature conditions from the type of graph used by Jefferson; and how inadequate this graph is for generalizing. One might suspect, for example, from the January 1939 readings, that Cincinnati experiences no truly frigid temperatures, whereas the truth of the matter is that temperatures fall below zero once or twice during many

the seasonal sweep of temperatures for the entire year (^j, the 2-month graph); (2) it indicates the normal diurnal temperature range for each month of the year (^{mj}); (3) it suggests the degree of temperature variability that can be expected each month (^m); (4) it shows the length of the normal growing season (^{mjk}); (5) it is not bulky or unwieldy (^j, the 12-month graph); (6) data for its construction are readily available (^j); (7) the graph

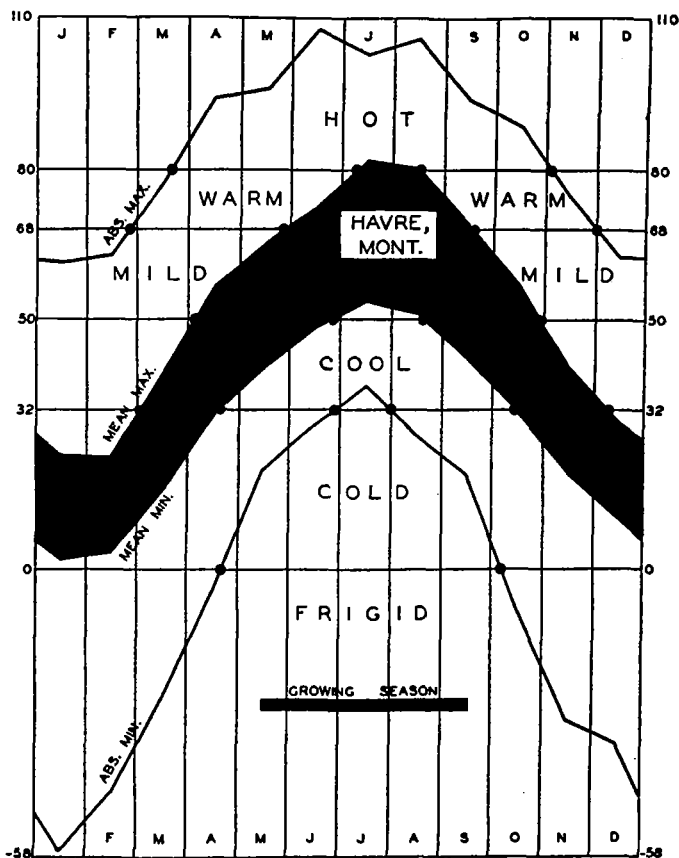


FIGURE 5.—Temperature graph for Havre, Mont. Note (1) the great seasonal range in temperature (middle latitude, continental location); (2) the fairly large "normal" diurnal range in temperature (dry atmosphere); (3) the greater "normal" diurnal range of summer as compared with winter (summer sun control); (4) the indication of vigorous and frequent temperature extremes throughout the year, but especially during winter (winter storm control); (5) the short growing season.

winters. Likewise, the extreme warm spell of the first third of January 1939 is very exceptional. In other words, the January 1939 curve might easily lead one who is unacquainted with Cincinnati winter weather to believe it was characteristically cool to mild, but a glance at figure 1 will prove otherwise. Finally, compare the simplicity and readability of the 4-curve graph with the 7-curve graph used by Kincer.

Instructive comparisons can likewise be made between the 4-line graph for Cincinnati and similar graphs for Havre, Mont., (fig. 5), a dry, interior, middle-latitude station; San Juan, P. R. (fig. 6), a wet, tropical station; Seattle, Wash., (fig. 7), a west-coast marine, middle-latitude station; and La Quiaca, Argentina (fig. 8), a dry, high-altitude, tropical station.

Summarizing, the advantages of the temperature graph proposed in this paper are the following:⁵ (1) It shows

⁵ Those features that are not possessed by the common mean monthly temperature graph are indicated by *; those that are missing from the Jefferson graph are indicated by †; those that are absent from the Kincer graph are indicated by ‡.

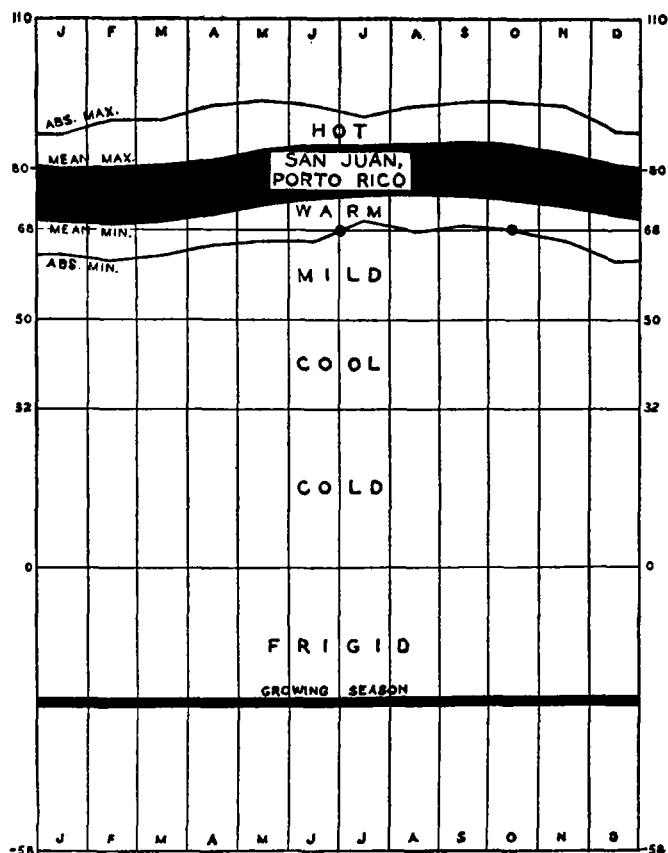


FIGURE 6.—Temperature graph for San Juan, P. R. Note (1) the small seasonal range in temperature (low latitude, insular location); (2) the moderate "normal" diurnal range (humid atmosphere, low altitude); (3) the lack of great temperature extremes (sun control dominant throughout the year); (4) the year-round growing season.

consists of only a few simple curves that are readily interpreted at a glance (^{jk}); (8) the data presented refer to a series of years and not to a single year (^j); (9) the temperature conditions can be read directly in descriptive terms (^{mjk}).

The sole disadvantage of the proposed graph, or so it appears to the author, is the fact that it does not give as detailed a picture of actual day-to-day changes in temperature as does Jefferson's excellent graph. When such detail is *necessary*, the latter type of chart is to be recommended.

The writer claims nothing more in respect to originality about his proposed temperature graph than that it is a hybrid of those prepared by Kincer, Jefferson, and others. Nevertheless, it is felt that this graph does mark a step forward in the gradual evolution of a means of temperature representation that will completely fulfill the needs of the geographer.

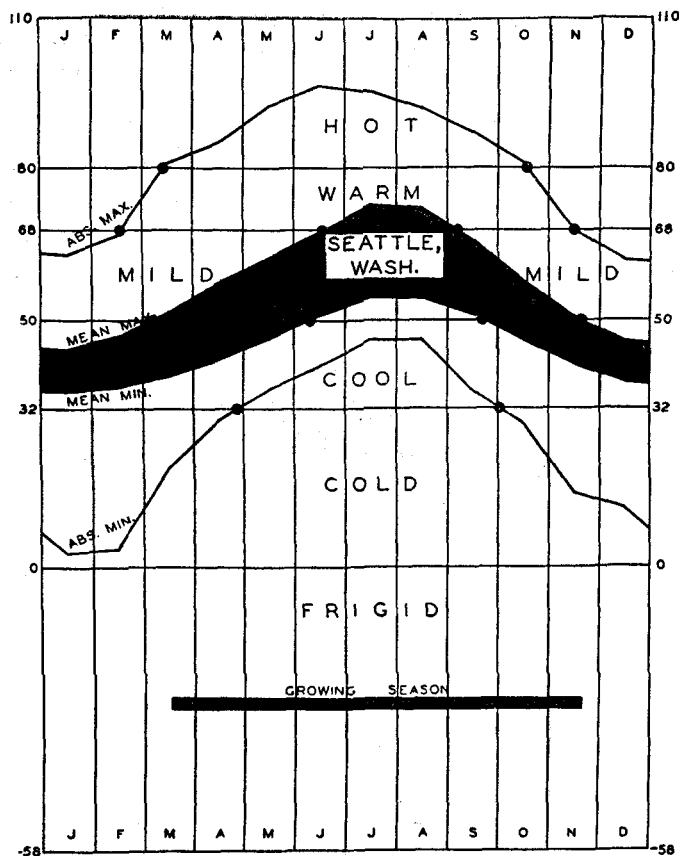


FIGURE 7.—Temperature graph for Seattle, Wash. Note (1) the relatively small seasonal range in temperature for the latitude (marine location); (2) the moderate "normal" diurnal range (humid atmosphere, low altitude); (3) the greater "normal" diurnal range of summer as compared with winter (summer sun control); (5) the long growing season for the latitude.

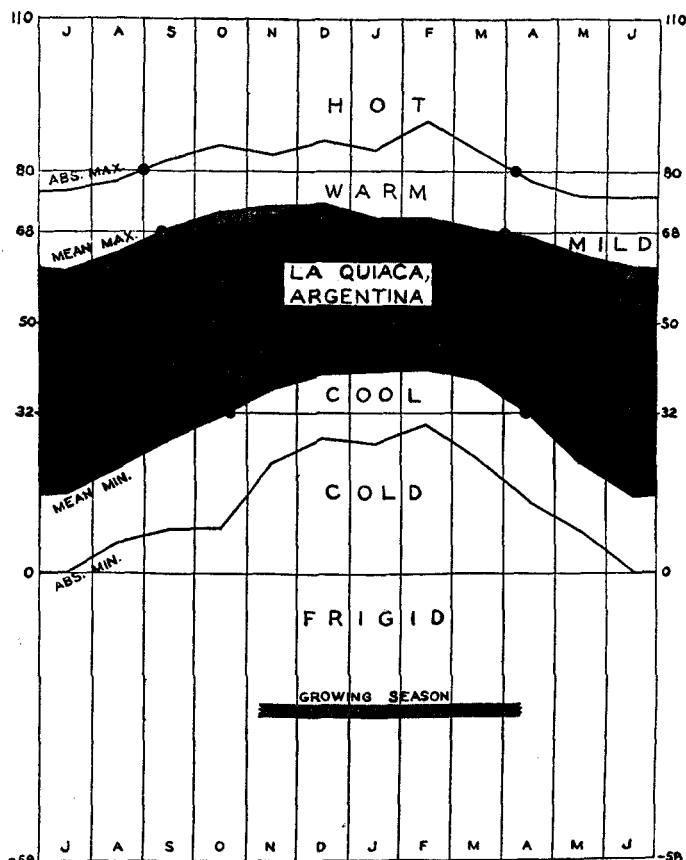


FIGURE 8.—Temperature graph for La Quiaca, Argentina. This station is located in extreme northern Argentina, at an elevation of approximately 11,000 feet. Note (1) the small seasonal range in temperature (low latitude location); (2) the excessive "normal" diurnal range (very high altitude, dry atmosphere); (3) the lack of great temperature extremes (sun control dominant rather than storm control); (4) the short growing season for the latitude.

SOME PRESSURE-PRECIPITATION TREND RELATIONS

By J. B. KINCER

[Weather Bureau, Washington, D. C., February 1941]

When smoothed curves of weather data covering long periods of time are plotted, the curves show successive wavelike variations depicting alternating fluctuations from wet to dry periods, from relatively cold to abnormally warm, etc.

Before the days of Galileo and Torricelli the vacuum pump was used extensively, but the only explanation of the physics involved was that "Nature abhors a vacuum." Similarly, in an attempt to offer a physical explanation of the complex and intricate processes of Nature that operate to produce these characteristic weather variations, we, today, can do little more than paraphrase the old Florentine gardener's explanation of the vacuum pump: "Nature abhors a straight line."

During recent years much has been learned about trend tendencies in temperature and precipitation—especially the latter. But little attention has been given to the characteristics of long-time barometric pressure tendencies. From our knowledge of the phenomena of air masses and their direct and indirect relations to the occurrence of precipitation, it naturally would be assumed that long-time precipitation trends should have a general relation to sustained pressure anomalies; in other words, that precipitation climatology is directly related to air-mass climatology. We have therefore made extensive summations of pressure anomalies for the past half century, and

PRESSURE TRENDS — N. TO S. — CENTRAL U.S. 10 YEAR MOVING SUMS OF DEPARTURE FROM NORMAL

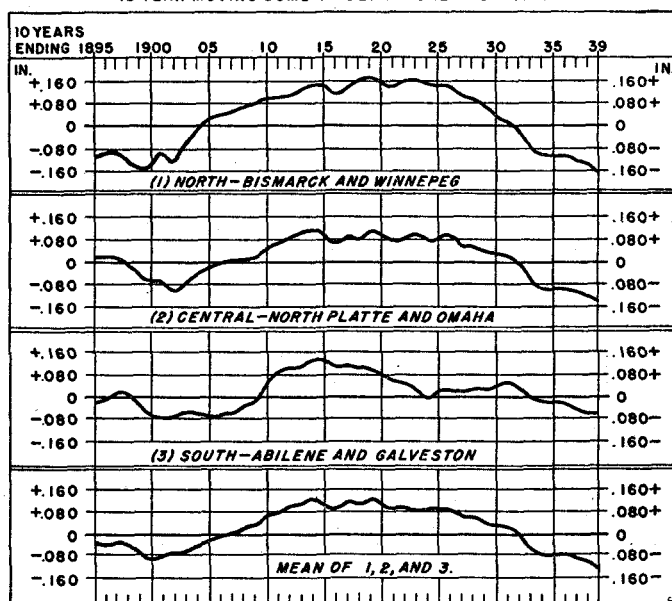


FIGURE 1.